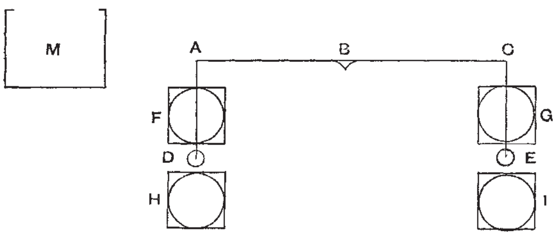
the friction of the mercury are avoided by connecting the vessels by wires with the earth.

If H and I form a mass of lead, I infer that three interchanges of D and E will be required, so that each weight shall be brought opposite the top and bottom of each mass to eliminate want of homogeneity in the lead. In the plan I propose only one interchange will be needed.

The effect, if any, of the vessels full of mercury being at



unequal distances from the arms of the balance can be readily determined and allowed for.

The plan I suggest may have already presented itself to the eminent scientists who have originated their notable improvement on Von Jolly's plan. The pleasure I had in reading the account of their proposed research has prompted me to make these suggestions. ALFRED M. MAYER

Stevens Institute of Technology, Hoboken, New Jersey, February 7

Bees and Flowers

As there is a prevailing idea that bees prefer red and blue to other colours, the following observations on their habits may be of interest:—The common hive bees were very busy among the flowers in the garden this morning. Those most frequented were yellow crocus, snowdrop, and Christmas rose. Next in order, winter aconite, yellow jessamine, and blue scilla. On sweet blue violets and on a dwarf erica, which is now flowering, I could see none. Hitherto my observations led me to suppose they never visited the blue scilla for honey, as I had never seen them settle down to it in a business-like manner, but simply flit over it and go to something else. G. W. BULMAN

Corbridge-on-Lyne

Free Lectures

I OBSERVED in NATURE for February 19 (p. 367) a reference to the free lectures at Liverpool, and the inquiry, Why cannot the same thing be done in other large towns? It may interest your readers to learn that a series of free lectures has been given during the past two winters by the professors of this College. Tickets for these lectures are distributed through the agency of a committee composed partly of employers, and the attendance at each lecture numbers between 600 and 700. The audience consists wholly of persons in receipt of weekly wages, the services of the lecturers are given gratuitously, and no charge whatever is made for admission. The small expenses of printing and issuing programmes and tickets are defrayed by the Committee. I inclose the syllabus of this, the second year's course, now drawing to a conclusion.

In addition to these lectures we have from time to time free lectures by gentlemen possessing special knowledge of the contents of the Free Libraries. These, too, are attended by a large number, chiefly of working people, and when the art galleries are completed next year arrangements of a similar kind will doubtless be made in connection with them. WILLIAM A. TILDEN

The Mason Science College, Birmingham, February 24

A Tracing Paper Screen

I CAN add to the testimony of Mr. Charles Taylor about the efficiency of a screen of tracing paper. I have used for several years a small screen of tracing cloth mounted on rollers like a map. It is very portable and soon fixed. With a sciopticon lantern (oil lamp) I have shown transparencies in the winter months to an audience of seven hundred men in a Midland Railway mess-room during the breakfast hour—8.15 to 8.50 a.m.—though the windows are by no means in the best position, and the room is lighted by skylights as well as by side windows. It is a pity this screen is not better known and more extensively used for scientific lectures. H. ARNOLD BEMROSE

Irongate, Derby, February 28

An Author's Gratitude

I WISH to express my gratitude to NATURE and to the reviewer in NATURE of my little pamphlet on Electrical Units for exposing a compound error by which the farad came to be described as a fraction of the electrostatic C.G.S. unit of capacity instead of the electro-magnetic unit. Was there ever a greater blunder? It was as if I had said the value of the tenth part of a farthing is sufficient to pay off a million times the National Debt of Great Britain. On recovering from the shock occasioned by the revelation, I hastened to the printer, and got him to correct the error "ere the sun went down," and now I overflow with gratitude to your reviewer, who has relieved me of the awful incubus of an error of the 10^{20} magnitude.

RICHARD WORMELL

SCIENTIFIC LABORATORIES[1]

I FEEL that the present occasion, upon which you have done me the honour to ask me to preside, is one of very great importance indeed, and I wish some person more competent to preside on such an occasion and give a suitable inaugural address were in my place. I am afraid I must confine myself to something not at all worthy of the greatness of an occasion which is almost the opening of a new university. Not quite so, because the real opening of this college took place several months ago; but still it is an occasion which I feel to be much more than merely the opening of a department—a working department—in the college; an occasion of so great moment that I regret that I shall not be able to give anything that could be properly considered a worthy inaugural address. I shall be obliged to ask your indulgence if I confine myself specially to departments with which I am personally familiar—scientific laboratories. The laboratory of a scientific man is his place of work. The laboratory of the geologist and of the naturalist is the face of this beautiful world. The geologist's laboratory is the mountain, the ravine, and the seashore. The naturalist and the botanist go to foreign lands, to study the wonders of nature, and describe and classify the results of their observations. But they must do more than merely describe, represent, and depict what they have seen. They must bring home the products of their expeditions to their studies, and have recourse to the appliances of the laboratory properly so-called for their thorough and detailed examination. The naturalist in his laboratory with his microscope and appliances for the keenest examination, learns to know more than can be learned by merely looking at external beauties. The geologist brings his specimens to the chemist—is himself a chemist perhaps—brings his crystals to the physical laboratory to be examined as to their physical properties, their hardness, the angles between their faces, their optical qualities. Some people might think this an ignoble way to deal with crystals. But it is not so to the trained eye and deeper thought of the scientific man. The scientific man sees and feels beauty as much as any mere observer—as much as any artist or painter. But he also sees something underlying that beauty; he wishes to learn something of the actions and forces producing those beautiful results. The necessity for study below the surface seems to have been earliest recognised in anatomy, and earliest carried out in human anatomy. I am not going to speak of the work of scientific research generally, but with reference to the special occasion which brings us here this day—the opening of the chemical and physical laboratories of the University College of North Wales. I am going to speak

[1] Address by Prof. Sir William Thomson, F.R.S., on the occasion of the opening of the Laboratories of University College, Bangor.

of laboratories for students, laboratories in which the students work with their own hands. There have been laboratories of investigation from the earliest times. No doubt Aristotle had his; and Archimedes had a laboratory wherever he went—in his bath, even, he observed, and studied, and thought out the laws of hydrostatics. But those were not students' laboratories, and our special subject to-day is a students' laboratory, where they can meet together for the practical study of the various departments of science, where they will be brought together to use their eyes and hands—their eyes otherwise than in merely reading books and looking at pictures or drawings; their eyes to observe accurately, and their hands to experiment, in order to learn more than can be learned by mere observation. To teach students to so work and so learn is the object of a scientific students' laboratory.

The first scientific laboratory that ever existed was that of Frederick II., King of Sicily, and was established between 1200 and 1250. Acting under the advice of his chief physician, Martianus, he made a law that nobody should practise physic or surgery without having studied anatomy practically. He established a school of practical anatomy, to which students flocked from all parts of Europe for many years. Subsequently there was an anatomical school instituted at Bologna; and in those two schools we hear the first of students working in laboratories. The anatomical students' working-room has for several hundred years been generally recognised as an absolute necessity of medical education. But I believe there was no other branch of physical science where students worked in the laboratory until probably twenty years of the present century had passed away. The University of Glasgow is, I think, justly entitled to take some pride in the great modern expansion and extension of the system of giving students practical work in laboratories, as an addition to the education which previously had been confined almost entirely to book-work, or, at best, to attending lectures illustrated by experiments and diagrams. The first chemical laboratory for students, so far as I know, was that founded by a colleague of my own name, though no relation—Thomas Thomson,[1] the great chemist and mineralogist. Prior to 1831 a students' chemical laboratory, under Thomas Thomson, at Glasgow University, flourished and was attended by a large number of students. These were chiefly medical students, but a considerable number also were students who wished to learn chemistry to practise it in the various chemical manufactories in Glasgow and the North of England, while some went to learn chemistry solely for the sake of science. A chemical laboratory has now become indispensable in all universities. A notable development of chemical laboratories with reference to practical education in chemistry, was made by Liebig not many years after 1831. I fix that date from personal recollection. In 1831 I first came to Glasgow, and I well remember that the building containing the chemical lecture room and laboratory existed then. How long before 1831 it was built I do not at this moment recollect. The world-renowned laboratory of Liebig brought together all the young chemists of the day. If I were to name the great men who studied at Giessen I should have to name almost every one of the great chemists of the present day who were young forty years ago. His laboratory was in full and flourishing activity between 1841 and 1845, and continued so for several years more until he migrated to Munich. It is still, I believe, a prosperous institution, carrying out the aims of its founder with undiminished zeal and energy. One of those chemists now living, who was young forty years ago, told me a few days since that Liebig's laboratory looked like an old stable. I believe the building in which we are now assembled *was* an old stable, but I fail to discover that it looks like an old stable now. If Liebig's laboratory, looking like an old stable, brought out such results to astonish and benefit the world, what must we expect of the beautiful laboratory in which we are now met? What would Liebig not have given for the appliances and advantages afforded by the well-equipped buildings of the North Wales College at Bangor? What would Liebig not have given for the facilities which now exist in these admirably-appointed lecture-rooms in which we are now met, and for the carefully-equipped laboratories and working-rooms, and places for special experimental work covering the area of the old stables and coach-houses of the "Penrhyn Arms Hotel"! If the professors and the students in this College—I think I may already say this thriving College—will be inspired by the zeal of those who have worked before them, a great reward will result even in the first year of the existence of the institution.

With respect to physical laboratories I may be allowed, without being thought egotistical, to say something in which I must speak of my own action. The physical laboratory in the University of Glasgow is, I believe, the first of the physical laboratories of which we have now so many. When I entered upon the professorship of natural philosophy at Glasgow I found apparatus of a very old-fashioned kind. Much of it was more than a hundred years old, little of it less than fifty years old, and most of it was of worm-eaten mahogany. Still with such appliances year after year students of natural philosophy had been brought together and taught. The principles of dynamics and electricity had been well illustrated and well taught: as well taught as lectures and so imperfect apparatus—but apparatus merely of the lecture-illustration kind—could teach. But there was absolutely no provision of any kind for experimental investigation, still less idea, even, for anything like students' practical work. Students' laboratories in physical science were not then thought of. I remember one of the chemists of the Liebig school asking me what was the object of a physical laboratory. I replied that it was to investigate the properties of matter. I could give no better answer now. I may remind you that there is no philosophical division whatever between chemistry and physics. The distinction is that different properties are investigated by different sets of apparatus. The distinction between chemistry and physics must be merely a distinction of detail and of division of labour.

Soon after I entered my present chair in the University of Glasgow in 1845 I had occasion to undertake some investigations of certain electrodynamic qualities of matter, to answer questions which had been suggested by the results of mathematical theory, questions which could only be answered by direct experiment. The labour of observing proved too heavy, much of it could scarcely be carried on without two or more persons working together. I therefore invited students to aid in the work. They willingly accepted the invitation, and lent me most cheerful and able help. Soon after, other students, hearing that some of their class-fellows had got experimental work to do,

[1] [Note added February 12, 1885:—First Professor of Chemistry in Glasgow University; appointed 1818; held the chair till his death, 1852.

The minutes of the Faculty of Glasgow College show that as early as the first month of 1828, Prof. Thomas Thomson began applying for more commodious premises in which to carry on his work in the department of chemistry. For two years he kept his wants persistently before the Faculty (of which he, being only a "Regius Professor," was not a member) until January 1830, when his efforts were crowned with success. A plot of ground was then purchased at the corner of College Street and Shuttle Street, outside the College precincts, and operations were at once begun, and pushed on with such vigour that the buildings seem to have been finished towards the end of the same year. The building thus erected contained ample and well-designed accommodation for teaching and experimental work. There was a large class-room and a large and conveniently-arranged public laboratory for students, with private rooms for the professor and for the prosecution of experimental research by the professor and his assistants, or by students and others.

Part of the ground-floor of the premises was let to a tenant (the "Falstaff Tavern" for many years!). To-day I found the building still in existence, and occupied by "George Younger and Co.'s Yarn Stores." Nearly all the rest of the University Buildings within the College precincts have been pulled down within the last twelve years for the "College Railway Station," which now occupies the site of the old Glasgow College and University.—W. T.]

came to me and volunteered to assist in the investigation. I could not give them all work in the particular investigation with which I had commenced—"The electric convection of heat"—for want of means and time and possibilities of arrangement, but I did all in my power to find work for them on allied subjects (Electrodynamic Properties of Metals,[1] Moduluses of Elasticity of Metals, Elastic Fatigue, Atmospheric Electricity, &c.) I then had an ordinary class of a hundred students, of whom some attended lectures in natural philosophy two hours a day, and had nothing more to do from morning till night. Those were the palmy days of natural philosophy in the University of Glasgow—the pre-Commissional days. But the majority of the class really had very hard work, and many of them worked after class-hours for self-support. Some were engaged in teaching, some were city-missionaries, intending to go into the Established Church of Scotland or some other religious denomination of Scotland, or some of the denominations of Wales, for I always had many Welsh students. But about five and twenty of the whole number found time to come to me for experimental work several hours every day. In those days, as now, in the Scottish Universities all intending theological students took the "philosophical curriculum"—*zuerst collegium logicum*—then moral philosophy, and (generally last) natural philosophy. Three-fourths of my volunteer experimentalists used to be students who entered the theological classes immediately after the completion of the philosophical curriculum. I well remember the surprise of a great German Professor when he heard of this rule and usage: "What! do the theologians learn physics?" I said, "Yes, they all do; and many of them have made capital experiments." I believe they do not find that their theology suffers at all from having learned something of mathematics, and dynamics, and experimental physics before they enter upon it. I had then no other premises than the old lecture-room and the adjoining apparatus room. To meet my requirements for my new volunteer laboratory corps, the "Faculty" (the then governing body of the College) allotted to me an old wine-cellar, part of an old professor's house, the rest of which had been converted into lecture-rooms. This, with the bins swept away, and a water-supply and a sink added, served as physical laboratory (a name then unknown) for several years, till the University Commissioners came and abolished a certain old function of Glasgow University, the "Blackstone Examination." The examination room was left unprotected, its talisman, the old "Blackstone Chair," removed. I instantly annexed it (it was very convenient, adjoining the old wine-cellar and below the apparatus room); and, as soon as it could conveniently be done, obtained the sanction of the Faculty for the annexation. The Blackstone room and the old wine-cellar served well for physical laboratory till 1870, when the University was removed from its old site imbedded in the densest part of the city, to the airy hill-top on which it now stands. In the new University buildings ample and commodious provision was made for experimental work.

In that good old time some students used to come to me under the impression that the laboratory would prove an agreeable lounge, where they could meet pleasantly and spend the forenoon talking matters over. They were soon undeceived as to its being a lounge for idly whiling away time. I hope they were not altogether disappointed when they thought it would be agreeable, and I almost hope they found it even more agreeable than they expected. They certainly learned something of patience and perseverance, if not much science, in the six months of the College session. As a matter of general education for those not going to practise medicine, was it of any use entering a chemical or physical laboratory? I found as many as three-quarters of the students were destined for service in the religious denominations in after-life. I have frequently met some of those old students who had entered upon their profession as ministers, and have found that they always recollected with interest their experimental work at the University. They felt that the time they had spent in making definite and accurate measurements had not been time thrown away, because it educated them into accuracy,—it educated them into perseverance if they required such education. Some students even worked so hard in my laboratory that I had to interpose for the sake of their health. There is one thing I feel strongly in respect to investigation in physical or chemical laboratories—it leaves no room for shady, doubtful distinctions between truth, half-truth, whole falsehood. In the laboratory everything tested or tried is found either true or not true. Every result is *true*. Nothing not proved true is a *result;*—there is no such thing as doubtfulness. The search for absolute and unmistakable truth is promoted by laboratory work in a manner beyond all conception. It is a kind of work in which also patience and perseverance are promoted in a most marked degree. No labour must be shrunk from; everything must be carefully done. There is this which is satisfactory about it: that perseverance is sure to be rewarded. There is no failure in physical science. We do not always find the particular thing looked for; we often find that what we looked for does not exist, or that something else exists very different from what we expected to find; but that something is to be found in any investigation entered upon with intelligence and pursued with perseverance, is a certainty; and also that that something is not valueless follows as a matter of course. Every additional knowledge of the properties of matter is of value.

A large part of the work of a physical or chemical laboratory must be measurement. That might seem rather trying work; "harsh and crabbed" shall we say? Who cares to measure the length of a line in land surveying, or of a piece of cord, or of ribbon, or of cloth? These may not be in themselves essentially interesting occupations; but if it becomes necessary to measure something smaller than can be seen with the eye, the measurement itself becomes an object to inspire the worker with the greatest ardour. Dulness does not exist in science. What do you think of a measurement of something you can only gauge by inference from the performance of the apparatus tested in some peculiarly subtle way? The difficulties to be overcome in physical science in mere measurement are teeming with interest. Properties of matter, or forces to be contended with, oblige us to be always digressing. We cannot go on saying—"We will think of nothing but the object before us." Every person who aims at one object of course perseveres until he attains it; but he keeps his mind open until he can return to some other object never thought of at first, but which thrust itself on him as a difficulty occurring in the pursuit of the first object. The very disappointments in attaining objects sought after in the investigations of physical science are the richest sources of ultimate profit, and present satisfaction and pleasure, notwithstanding the difficulties and disappointments contended with. But I am afraid I am taxing your patience too much. I will only just say with reference to physical laboratories that they are now advancing to something of the method and consistent system that Thomas Thomson and Liebig so greatly gave to chemical laboratories. I, myself, have not done so much as I might have done in that way. The physical laboratory at Glasgow has, I believe, been, more than most others, devoted to whatever work occurred in physical investigation, measuring properties of matter, comparing thermometers, electrometers, galvanometers, and doing other practically useful work. We put the junior students at once into investigations, and let

[1] Results up to 1856 published under this title, as Bakerian Lecture for 1856 (*Trans. R. S.*, and republished recently in vol. ii. of "Collected Papers."—W. T.)

them measure and weigh whatever requires measurement and weighing in the course of the investigation. I look with admiration to what has been done by those who have worked up physical laboratories to their present advanced condition. The physical laboratories of King's College and University College, London, under the admirable organisation and work of Professor Adams and Professor Carey Foster; the Cavendish laboratory at Cambridge, originated by Clerk Maxwell, and admirably systematised and perfected by Lord Rayleigh, have rendered splendid services to physical science all over the world. Much has been done even to provide suitable text-books for use in the systematic practical training of students in laboratory work: for example, the "Treatise on Physical Measurement," by Kohlrausch, which has been for several years a most serviceable manual, and the lately published "Practical Physics" of Glazebrook and Shaw. The physical laboratory system has now become quite universal. No university in the world can now live unless it has a well-equipped laboratory. I hope you will all do your best to make the physical and chemical laboratories of this college a great success; that you will follow example in everything exemplary until the Bangor laboratories become a model to be followed in future laboratories in Wales, England, or any other part of the world. I was not quite accurate when I spoke of this new college in this City of Bangor as *the* University College of North Wales. My friend, Mr. Cadwaladr Davies, your secretary, has reminded me that there was a university of North Wales at Bangor-is-y-coed, in Flintshire—not a city, because it did not combine a bishop and a mayor—but a town which had the honour of having been the seat of the first Welsh university known to history. There may have been universities in Wales before the one which flourished 1200 years ago at Bangor-is-y-coed; but their history is lost in the long night of silence, because no sacred bard sung of their existence. The university of Bangor-is-y-coed had its bard, who tells us that the institution had 2100 students. There you have a worthy object of ambition for the city of Bangor! May it soon have a goodly proportion of the 2100. Perhaps not so long a time may elapse before your college and the other colleges in Wales may reach to such a number. Indeed, I do not see anything unreasonable in hoping and expecting that in a dozen years there will be 2100 university-students in Wales. The population of Wales is more than a million and a half, which is, I think, about a fourth of the population of Scotland; and I do not see why Wales should not have university students in proportion to its population as well as Scotland. I believe the brightness and activity of the Welsh intelligence will thoroughly take up the idea of a university, and profit by it to the utmost, and, I believe, the existence of this institution at Bangor will before twenty years have passed away, be looked upon as having been a great benefit to the Principality. What Wales gained by the university at Bangor-is-y-coed can scarcely now be told, but alas, for that university with its 2000 students, it was destroyed in the year 613 by Ethelfred, King of Northumbria, and its destruction was followed by 900 years of dark ages. Thus we see what the world lost by the annihilation of the first university of North Wales. Another bard, Lewis Glencothy, advocated and sang of the possibility of a university in Wales in the time of Henry VII. Richard Baxter, not a Welshman nor a bard but the great English Puritan divine, reported to the then Government under Cromwell in favour of a university for Wales. Cromwell died before action was taken, and nothing was done in the matter for nearly 200 years, when a very active desire sprang up and active co-operation among all parties was entered upon, for having a university established in Wales. We see everything now prospering in that direction. I look forward hopefully to the time when this college of Bangor—if not an independent university of its own—will be a college of the University of Wales. All the colleges of Wales, equipped to do the work of a university, might be united to form a University of Wales. There are very many important advantages in favour of such an arrangement. No doubt it is an object of honourable ambition; but it may be asked if a college does all the work of a university, what does it matter whether it is called a university or not? It is of considerable importance that your college should be either a university itself, or part of a university of which it is an integral college. One of the advantages would be that the teaching of the college would be enabled to take a more practical form than it can possibly take as long as its main purpose is that of preparing students for the degree examinations of London University. The degree system of London University fills a widespread want—a want felt over the whole range of the British empire; a want of marking by the stamp of a university degree, if not by some more suitable title, the possession of knowledge and of a certain amount of training by those who have not had the opportunity of obtaining that knowledge in any thoroughly equipped college or university. That is a splendid reason for the existence of the London University, and it has well fulfilled its reason for existence. But, for all that, it would be greatly better for the students of the University College of North Wales if the teaching were conducted with reference to an examination carried on by their own professors and colleague professors in other properly equipped Welsh colleges. It is the greatest mistake in respect to teaching and examining to think that the examiner is an inspector. An examiner of schools must to some extent take that position. But in university work teaching and examining must go side by side, hand in hand, day by day, week by week together, if the work is to be well done. The object of a university is teaching, not testing. Testing products comes at some times, and for some special purposes, to be a necessity; but in respect to the teaching of a university, the object of examination is to promote the teaching. The examination should be, in the first place, daily. No professor should meet his class without talking to them. He should talk to them and they to him. The French call a lecture a *conférence*, and I admire the idea involved in that name. Every lecture should be a conference of teacher and students. It is the true ideal of a professorial lecture. I have found that many students are afflicted when they come up to college with the disease called "aphasia." They will not answer when questioned, even when the very words of the answer are put in their mouths, or when the answer is simply "yes" or "no." That disease wears off in a few weeks, but the great cure for it is in repeated and careful and very free interchange of question and answer between teacher and student. Professors and students must speak to one another. One of the greatest things is to promote freedom of conversation in such classes, to cultivate in them the power of expressing ideas in words. Then something more definite than *viva voce* examination can come. Written examinations are very important, as training the student to express with clearness and accuracy the knowledge he has gained, and to work out problems, or numerical results, but they should be once a week to be beneficial. If only occurring once in two or three months they will lose their effect in promoting good teaching, and can be scarcely more than a test; if only once a year they are merely inspector's work. The object of the university should be teaching, and examining should only be part of its work, and that only so far as it promotes teaching. The credit of the University should depend on good teaching, and no candidate should be granted a degree who does not show that he has taken advantage of the good teaching. But it is impossible to carry out that programme to best advantage by a college which is not in itself an integral part of a university. Such examinations as those of the London University are necessarily arranged to suit thousands of candidates who have learned in different schools, and

cannot always contain questions that would be most suitable for one particular mode of teaching. The kind of questions set would be of a different nature if the giving of the questions devolved upon those who had in hand the teaching. Those who have the teaching can give an examination vastly more useful and one that would re-act on the teaching in a way that an examination of a multitude of students trained at all kinds of institutions, and many merely by private reading, could not possibly do. Therefore, it seems to be a matter of high importance indeed that there should be a University of Wales; that you should consider it to be a great object to be attained, sooner or later—but the sooner the better—the establishment of the University of Wales, with the University College of North Wales an integral part of it. I have much pleasure in wishing the University College of North Wales every success, and I trust that the laboratories now opened may prove of great value in promoting and aiding the study of science.

POLYNOMIALS IN ZOOLOGY[1]

SINCE the days of Linnæus scientific zoologists have universally adopted the binomial system of nomenclature, which was invented and introduced by that great naturalist. So long as the idea of the fixity of species, as originally created entities, prevailed, there was no excuse for deviating from the Linnean plan. Such an idea as a transitional series between two species, or the division of a species into two or more local forms, was hardly understood by the older authors. But of late years, since the general acceptance of the derivative origin of species, it has become universally acknowledged that sub-species and transitional forms do exist in Nature, and many and various plans have been proposed for indicating them. Trinomials—that is, the usage of three names, of which the last is that of the sub-species—are in great favour with a rising section of American zoologists, and there is much to be said in their defence. But the concession of three terms, it is said, would in some cases not be sufficient. Quadrinomials and Polynomials must necessarily follow, and render nomenclature inconveniently long. Mr. S. Garman, the well-known herpetologist of the Comparative Museum of Zoology at Harvard College, Cambridge, replies, in the pamphlet now before us, to the assertion "that there is no other or better method than "polynomials." Mr. Garman proposes to designate the different forms or sub-species of a species by symbols such as (A), (B), (C), (D). Supposing that the (C) form is found to consist of several sub-varieties he would name them ($C.^a$), ($C.^b$), ($C.^c$). Still further subdivisions might be indicated as forms (C^{a1}), (C^{a2}), (C^{a3}), and ($C^{a1'}$), ($C^{a1''}$), &c. Thus the polynomial "*Amblystoma tigrinum mavortium hallowelli suspectum maculatissimum*" would be reduced to "($C.^{a1'}$) *Amblystoma tigrinum*," the "advantage" of which for general literature is "apparent"! But is not this a case in which it may be said that the proposed remedy is as bad as the disease?

TEMPERED GLASS

WE are very pleased to be able to chronicle an application which Mr. Frederick Siemens has recently made in his regenerative gas radiating furnace, described in the autumn of last year (NATURE, vol. xxxi. p. 7). It consists in the production of glass which appears to be of a very homogeneous character and of considerable strength and hardness, and will doubtless become available for a number of useful purposes. The scientific principle which is applied in the three distinct processes to which we propose to refer shortly, is that of keeping the whole body of the glass at a uniform temperature during the operations of heating and cooling—that is to say, that at each unit of time the whole mass shall be at one temperature. Two methods have hitherto been employed by means of which glass has been rendered more or less independent of variation of temperature. The oldest of these is that carried on in the annealing kiln, in which the manufactured articles of glass are allowed to cool very slowly. The more modern is that of De la Bastie; in this process the finished articles of glass had generally to be annealed in the first instance, then heated to such a temperature as to soften them, when they were immersed in a bath of heated oil maintained at a temperature above 300° C., which was said to make them tough. The objection to annealing is mainly that of cost, but the objection to the De la Bastie process is that it is wrong in principle, as, owing to the manner in which cooling is effected, the glass is in a state of tension throughout, which is brought to evidence by means of the polariscope. The glass produced by the processes to be described are almost free from internal strain, and Mr. Siemens holds that, could the principle he propounds be carried out perfectly in practice, the glass would be free from tension throughout its whole mass. A corollary which may apparently be drawn from this proposition is that every metal not cooled in the way proposed is in strain; but that, owing to the much greater tensile strength of metals, the state of tension does not become evident in the same manner as in glass, which is notably brittle.

Press-hardened Glass.—Only glass of the very best quality is suitable for hardening. It is cut into the proposed shapes and placed in the radiation furnace until soft; it is then removed and placed between cold metal plates, and cooled down in the proportion of its volume or capacity for heat. Glass may be cooled so rapidly by this means that the diamond will not touch it; the process is mostly applied to sheet and plate glass, which may either be plain or decorated, and whose strength is thereby increased eight times. The degree of hardening which may be attained depends on the temperature to which the glass is heated and the rate at which it is cooled. The higher the temperature, and the more quickly the glass is cooled, the harder is the glass. Thus, for very quick cooling copper plates are used in the presses, and the glass is rendered exceedingly hard; when a less degree of hardness is desired, iron plates, or even these covered with asbestos, or clay slabs, may be employed.

Sheet-glass of ordinary thickness is heated in a minute and cooled in half a minute. It is remarkable that this can be effected in so short a space of time without injury to the glass, and is due to the uniformity of the heating and cooling operations. Owing to the high temperature at which this process is carried on, more refractory enamels, such as those used for porcelain, can be applied, and the enamel is thus rendered as indestructible as the glass itself.

Semi-hardening is employed for goods to which presses cannot be easily applied. The glass is heated up to a high temperature, but not to such a degree as to affect its shape, and is then placed within an iron casing having internal projecting ribs so arranged as to hold the glass article in position and to touch it at the fewest possible points. The casing with its inclosure is cooled in the open air. The process is only applicable to articles of nearly uniform thickness throughout; it increases the strength of the glass about three times, and renders it less liable to be effected by changes of temperature than ordinary glass is.

The third kind of glass, which is known as *hard-cast glass*, has not yet been introduced commercially, but samples of the work produced in the form of sleepers, tramway-rails, grindstones, and floor-plates were exhibited at the meeting. The method of production is very simple.

[1] "On the Use of Polynomials and Names in Zoology." By S. Garman, Cambridge, Mass., U.S.A. From the *Proceedings* of the Boston Society of Natural History, March 19, 1884.